

## ***Health Consultation***

### ***Able Pest Control:***

### **Evaluation of Soil, Dust and Biological Sampling Data**

June 2, 2000

Revised contact information September 18, 2003

**Prepared by  
The Washington State Department of Health  
Under a Cooperative Agreement with the  
Agency for Toxic Substances and Disease Registry**



## **FOREWORD**

The Washington State Department of Health (DOH) has prepared this Health Consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This Health Consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this Health Consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The Health Consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substances. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site or industrial site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

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## Glossary

<b>Acute</b>	Occurring over a short period of time. An acute exposure is one which lasts for less than 2 weeks.
<b>Agency for Toxic Substances and Disease Registry (ATSDR)</b>	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
<b>Cancer Risk Evaluation Guide (CREG)</b>	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
<b>Cancer Slope Factor</b>	A number assigned to a cancer causing chemical that is used to estimate it's ability to cause cancer in humans.
<b>Carcinogen</b>	Any substance that can cause or contribute to the production of cancer.
<b>Chronic</b>	A long period of time. A chronic exposure is one which lasts for a year or longer.
<b>Comparison value (Screening Level)</b>	A concentration of a chemical in soil, air or water that, if exceeded, requires further evaluation as a contaminant of potential health concern. The terms comparison value and screening level are often used synonymously.
<b>Contaminant</b>	Any chemical that exists in the environment or living organisms that is not normally found there.
<b>Dose</b>	A dose is the amount of a substance that gets into the body through ingestion, skin absorption or inhalation. It is calculated per kilogram of body weight per day.
<b>Exposure</b>	Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long term (chronic).
<b>Hazardous substance</b>	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
<b>Indeterminate public health hazard</b>	Sites for which no conclusions about public health hazard can be made because data are lacking.
<b>Ingestion rate</b>	The amount of an environmental medium which could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
<b>Media</b>	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
<b>Minimal Risk Level (MRL)</b>	An amount of chemical that gets into the body (i.e. dose) below which health effects are not expected. MRLs are derived by ATSDR for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

<b>Model Toxics Control Act (MTCA)</b>	The hazardous waste cleanup law for Washington State.
<b>No apparent public health hazard</b>	Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.
<b>No public health hazard</b>	Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.
<b>Oral Reference Dose (RfD)</b>	An amount of chemical ingested into the body (i.e. dose) below which health effects are not expected. RfDs are published by EPA.
<b>Organic</b>	Compounds composed of carbon, including materials such as solvents, oils, and pesticides which are not easily dissolved in water.
<b>Parts per billion (ppb)/Parts per million (ppm)</b>	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
<b>Remedial investigation</b>	A study designed to collect the data necessary to determine the nature and extent of contamination at a site.
<b>Risk</b>	The probability that something will cause injury, linked with the potential severity of that injury. Risk is usually indicated by how many extra cancers may appear in a group of people who are exposed to a particular substance at a given concentration, in a particular pathway, and for a specified period of time. For example, a 1%, or 1 in 100 risk indicates that for 100 people who may be exposed, 1 person may experience cancer as a result of the exposure.
<b>Route of exposure</b>	The way in which a person may contact a chemical substance that includes ingestion, skin contact and breathing.
<b>U.S. Environmental Protection Agency (EPA)</b>	Established in 1970 to bring together parts of various government agencies involved with the control of pollution.

## Background and Statement of Issues

The Washington State Department of Health (DOH) has prepared this health consultation to address the potential health hazard associated with exposure to organochlorine pesticides in soil at the former Able Pest Control facility located in Seattle, King County, Washington. A previous health consultation prepared by DOH concluded that a potential health hazard existed for residents living at the former Able Pest Control site.<sup>1</sup> This consultation addresses new soil, indoor dust, blood and breast milk sampling. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

The site is located in a residential area at 18115 62nd Avenue NE bordered by 62nd Avenue to the east, residences to the north and west and the Lake Forest Park Preschool to the south (Figure 1). Able Pest Control operated at the site from 1969 through 1985. The facility was sold in 1986 and converted into a residence in 1994. The residence consists of two units, one in the basement and one at ground level, both of which are currently occupied. Discussions with the previous owner and employees of Able Pest Control indicate that pesticides were stored on-site. Mixing is thought to have occurred primarily at the application site but some mixing of bait and pesticide did occur in the basement. Rinsate was reportedly dispensed at the application site. A shed underneath the porch and the garage have been identified as pesticide storage areas.<sup>2</sup> The shed was converted to a bedroom for the downstairs apartment requiring excavation of soil and pouring of a concrete slab. The soil from this excavation was piled in the southwest corner of the property.<sup>3</sup>

### Environmental Contamination

In July 1997, the Washington State Department of Ecology (Ecology) collected two soil samples at the base of the foundation near the basement bedroom (former shed area). Chlordane and dieldrin were detected at 12 and 0.4 parts per million (ppm), respectively, in one of these samples.<sup>2,4</sup> A tenant of the basement apartment had samples of a photograph, carpet and furniture stuffing analyzed for pesticides. A composite sample of the carpet contained 59 - 66 ppm chlordane, 3.5 - 3.8 ppm lindane, 4.1 - 4.2 ppm DDE and 3.3 - 3.5 ppm DDT. Lower levels of chlordane and DDT were found in the photograph. Analysis of a wipe sample taken from the concrete slab foundation beneath the basement carpeting detected no pesticides.<sup>5</sup>

#### Parts per million

One part per million can be thought of as one drop of gasoline in a full size gas tank.

In response to the detection of these pesticides, the current owner of the property contracted for the removal of soil from the south foundation of the building along the basement bedroom. All soil removed during this action was disposed of off-site. As a follow-up to this soil removal action, additional soil samples were taken from underneath the concrete slab foundation of the basement bedroom and found to contain chlordane at 0.23 ppm. The soil pile located in the southwest corner of the property that resulted from the excavation of this foundation was also

found to contain 8.5 ppm of chlordane and 1.1 ppm of dieldrin.<sup>6</sup> Sampling of a nearby pre-school detected low levels of chlordane and dieldrin.<sup>7</sup>

More soil was excavated and removed from both the preschool grounds and the south border of the former Able Pest Control property. Approximately 10 tons of soil were removed from the northwest corner of the preschool play area. Soil samples taken at the bottom of this excavation indicate that levels of pesticides are below MTCA standards. The area was regraded with clean soil and seeded with grass.<sup>8</sup> Approximately 70 tons of soil were removed from the Able Pest Control property including the contaminated soil pile noted above. Sampling conducted during this excavation revealed higher contamination than was previously found including a maximum of 175 ppm chlordane and 21 ppm heptachlor. The excavated area was backfilled with clean soil and landscaped. Additional steps were taken to prevent erosion of soil onto preschool property from areas that were not cleaned up and could contain pesticides.<sup>8</sup>

A health consultation released by DOH in November 1998, recommended further soil sampling along with indoor dust sampling to better characterize exposure to residents currently living on-site.<sup>1,a</sup> In response to these recommendations, DOH conducted an exposure investigation between February and April 1999 that included indoor dust sampling and analysis for organochlorine pesticides. Indoor dust samples were taken from the carpeting at each of the two on-site residences. A third indoor dust carpet sample was taken at a former tenant's new residence to serve as a reference value. Finally, a fourth dust sample was collected from a piece of carpet removed from one of the on-site basement bedrooms. In addition, extensive surface and sub-surface soil sampling was performed as part of a Remedial Investigation/Feasibility Study (RI/FS) between May and June 1999.<sup>8</sup>

The maximum detected levels of the contaminants of concern in surface soil and indoor dust are given below in Table 1. Complete results of indoor dust sample analyses are given in Appendix B. Contaminants of concern were chosen based on a comparison of levels detected in soil or indoor dust with the corresponding ATSDR soil screening level for each contaminant. Screening levels are based on the ability of the contaminant to cause either *cancerous* or *non-cancerous* health effects. Each of the contaminants of concern given in Table 1 exceed their respective screening value. Contaminants of concern do not necessarily represent a public health hazard, but signify the need for further evaluation.

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<sup>a</sup> Both the basement and upstairs apartments were vacated by the late summer/early fall 1999 in preparation for anticipated soil removal actions at the site.

**Table 1.** Contaminants of concern in surface soil and indoor dust at the former Able Pest Control site given in parts per million (ppm).

Contaminant	Maximum Level in Surface Soil <sup>a</sup>	Percent Detections in Surface Soil <sup>a</sup>	Indoor Dust <sup>b</sup>	ATSDR Comparison Values <sup>c</sup>		EPA Cancer Class
				Value	Source	
Aldrin	3.4	36.2	ND	0.04	CREG	B2
Chlordane	1,120 <sup>d</sup>	100	7.1	0.5	CREG	B2
DDD	13	70.2	ND	3	CREG	B2
DDT	26	78.7	ND	2	CREG	B2
Dieldrin	64	74.5	0.25	0.04	CREG	B2
Heptachlor Epoxide	1.5	70.2	ND	0.2	CREG	B2
Heptachlor	190	31.9	ND	0.08	CREG	B2
Polychlorinated biphenyls	ND	NA	200	0.4	CREG	B2

a = Based on Remedial Investigation data. Does not include samples taken off-site (Sub-area 7) or beneath the foundation (Sub-area 1).

b = Indoor dust sample results are given in Appendix B.

c = Comparison values are based on soil exposure.

d = Duplicate sample with Ecology gave the higher result of 3,770 ppm.

ND = not detected

B2 = probable human carcinogen

CREG = Cancer Risk Evaluation Guide

NA = not available

D = not classifiable as to carcinogenicity

## Biological Testing

Blood serum and breast milk samples were also collected as part of the DOH exposure investigation. A total of five blood serum samples were collected and analyzed for organochlorine pesticides and their metabolites; three from former tenants of the basement apartment, one from a current tenant of the basement apartment and one from a current tenant of the upstairs apartment. In addition, a breast milk sample was collected from each of two breast feeding mothers living in either apartment.

The only pesticide detected in blood serum samples was DDE (p,p'-dichlorodiphenyl dichloroethene) at a maximum of 4.0 parts per billion (ppb). This is well below the reference value of 52.9 ppb provided by the laboratory. DDE is formed in the body following exposure to the pesticide DDT (p,p'-dichlorodiphenyl trichloroethane) which was detected in surface soil and is a contaminant of concern. DDE is expected to be found in the blood of most people due to past

### **Reference Value**

An estimate of the level of a contaminant that would be present without any known exposure. This value is sometimes referred to as "background".

widespread use of DDT and its persistence in both the body and environment.<sup>b</sup>

The former on-site tenant elected to test her and her son's blood serum for PCBs. Concern for possible PCB exposure arose following the detection of PCBs in dust sampled from carpeting that had been removed from the basement apartment during renovation. PCBs were not detected in either of these blood serum samples nor have they been detected in any soil sampling at the site.

One of two breast milk samples showed elevated levels of some organochlorines pesticides, their metabolites and polychlorinated biphenyls (PCBs). The results of the breast milk analysis are presented along with reference values in Table 2 below.

**Table 2.** Results of Breast Milk Analysis for Organochlorine Pesticides given in parts per billion (ppb).

Chemical	Breast Milk			Breast Milk Fat		
	Resident 1	Resident 2	Reference Value <sup>a</sup>	Resident 1	Resident 2	Reference Value <sup>a</sup>
B-Hexachlorocyclohexane	0.028	0.263	0.71	0.9	<b>23.6</b>	22.6
Lindane	< 0.098	<b>0.084</b>	0.04	< 3.16	<b>7.5</b>	1.03
Aldrin	< 0.019	< 0.039	NA	< 0.61	< 1.26	NA
Heptachlor epoxide	0.062	<b>0.226</b>	0.11	2	<b>20.2</b>	3.77
Oxychlorane	0.108	<b>0.752</b>	0.42	3.5	<b>67.4</b>	13.4
<i>trans</i> -Nonachlor	0.079	<b>0.621</b>	0.55	2.6	<b>55.6</b>	17.5
p,p'-DDE	0.831	<b>18.805</b>	6.78	26.9	<b>1680</b>	222
Dieldrin	0.039	0.157	0.31	1.3	<b>14.1</b>	9.78
Endrin	< 0.032	< 0.065	NA	< 1.03	< 2.10	NA
o,p'-DDT	< 0.058	<b>0.146</b>	0.09	< 1.87	<b>13.1</b>	2.83
p,p'-DDT	< 0.058	0.12	0.64	< 1.87	10.8	22.1
Mirex	< 0.051	< 0.078	0.06	< 1.65	< 2.52	1.89
Polychlorinated biphenyls (PCBs)	0.25	4.51	7.21	8.2	<b>404</b>	238

a = Average concentrations in breast milk samples taken from a study of Canadian women with no known previous exposure. (Newsome et al., PCB and Organochlorine Pesticides in Canadian Milk – 1992. *Chemosphere*, Vol. 30(11) pp.2143-53, 1995).

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<sup>b</sup> DDT is no longer used in the United States but is still used by other countries primarily for the control of malaria.



## Discussion

The following discussion addresses the exposure and potential health hazards associated with the contaminants of concern found in soil and indoor dust at the Able Pest Control site. Results of blood serum and breast milk analysis are also discussed below. Chlordane and dieldrin are the primary contaminants of concern detected in soil at the former Able Pest Control property. Other organochlorine pesticides were found less frequently and at lower levels. Some contaminated soil has been removed from the site and the nearby preschool.

### Surface soil

As noted in a previous health consultation, a *potential* health hazard existed for on-site residents exposed to pesticides in surface soil through accidental ingestion, skin contact and dust inhalation. This evaluation was inconclusive because of insufficient soil sampling and a lack of indoor dust sampling. Since this evaluation, comprehensive sampling of both surface soil and indoor dust has established the presence of organochlorine pesticides in surface soil and indoor dust at levels of health concern. Residents of both on-site apartments moved out as of October 1999 in preparation for excavation and removal of contaminated soil from the property.

Exposure to contaminants of concern in surface soil was reevaluated based on additional data generated during the RI/FS. *These new data support the previous finding that exposure of residents at the former Able Pest Control property to pesticides in soil carries some increased risk for cancer and non-cancer adverse health effects.*

### *Non-cancer effects*

Doses were estimated for a young child exposed for several years to chlordane, dieldrin, aldrin, DDT, DDE, heptachlor and heptachlor epoxide in soil. Assumptions and calculations used to derive these doses are presented in Appendix C. Only those doses estimated for chlordane and dieldrin exceed their corresponding oral reference dose (RfD). The exposure doses estimated for chlordane and dieldrin in soil are two and three times above their RfDs, respectively.

RfDs are set by the Environmental Protection Agency (EPA) as a level below which non-cancerous adverse health effects are not anticipated. It is important to note that the RfDs for these pesticides are set many times below the actual toxic effect levels upon which they are based. This process provides added public health protection. For example, although the estimated doses for chlordane and dieldrin exceed their respective RfDs, these doses are still hundreds of times below levels that caused liver toxicity. It is, therefore, unlikely that a child exposed to chlordane at this property would suffer any liver damage.

#### **Oral Reference Dose (RfD)**

An oral reference dose (RfD) is a level of exposure to chemicals below which non-cancerous effects are not expected. RfDs are set by the Environmental Protection Agency (EPA).

For each of the contaminants evaluated, the RfD is based on liver toxicity. It is important to consider *combined* exposure to these pesticides since they are present together in the soil and have a similar toxic effect (liver). The sum of the estimated doses for each contaminant of concern was six times higher than the “combined RfD.” This combined dose provides a estimate of the overall non-cancer risk that is driven primarily by chlordane and dieldrin.

Although the RfDs for the contaminants of concern are based primarily on liver toxicity, more recent evidence has indicated that nervous, immune and endocrine systems may also be targets of organochlorine exposure. Nervous system toxicity has been documented in humans receiving large doses of organochlorine pesticides through poisoning. Organochlorine pesticide poisoning can include mild symptoms such as loss of balance, headache, dizziness and tremors as well as severe effects such as convulsions, seizures and death depending upon the dose.<sup>9,10,11</sup> More relevant human studies have found evidence of adverse health effects in residents exposed following application of chlordane to their homes or workplace for termite control. Three such studies found evidence of neurotoxicity and immune system alterations in people exposed to technical chlordane applied to their homes/workplace several years prior to examination.<sup>12,13,14</sup> Although some of the human studies discussed above reported organochlorine serum and/or fat levels, data were insufficient to determine a relationship between these levels and health effects.

Organochlorine exposure has also been implicated in thyroid dysfunction. Several *in vitro* and animal studies have shown a reduction in thyroid hormone (thyroxine) levels in response to PCB exposure.<sup>15,16,17</sup> The implications of this effect are wide-ranging since thyroxine regulates carbohydrate and protein metabolism. A study in rats exposed *in utero* to PCBs found hearing deficits concurrent with decreasing thyroxine levels.<sup>18</sup> Rats exposed to benzene hexachloride and rams exposed to lindane and pentachlorophenol *in utero* also had decreased thyroxine levels.<sup>19,20</sup> Studies examining the potential for thyroid effects in humans are limited. One such study did not find a relationship between hexachlorobenzene in blood and thyroid effects.<sup>21</sup> Another study found no association between occupational exposure to organochlorines and depleted thyroxine levels.<sup>22</sup> Although the animal evidence cited above appears to link organochlorine exposure with thyroid effects, the data are not specific to chlordane and dieldrin, the two primary contaminants of concern.

Developmental effects have also been examined with respect to organochlorine pesticide exposure. Since organochlorines can accumulate in breast milk, exposure after birth may also be important with respect to this potential toxic endpoint.<sup>23,24,25,26</sup> Animal testing shows that chlordane can affect the immune system and hearing of the developing fetus.<sup>17,27</sup> No data were located relative to developmental toxicity in humans exposed to organochlorine pesticides. However, some studies indicate that *in utero* exposure to PCBs can reduce birth weight and affect the nervous and immune systems.<sup>28</sup>

### *Cancer effects*

Each of the contaminants of concern are classified by EPA as Group B2 probable human carcinogens. EPA designates a chemical as a B2 probable human carcinogen when there is sufficient animal evidence but inadequate or no human evidence of its ability to cause cancer. There is sufficient evidence that aldrin, chlordane, dieldrin, heptachlor and heptachlor epoxide can cause liver tumors in mice at very high and repeated doses. Two studies of human populations have found an association between chlordane exposure and non-Hodgkins lymphoma.<sup>9</sup> However, the people examined in these studies were exposed to many different types of pesticides other than the organochlorines found at the former Able Pest Control property. Some studies have linked exposure to dieldrin, DDE and PCBs with breast cancer while other studies have found no association between organochlorine exposure and any cancer endpoint.<sup>29,30,31,32,33,34</sup> The Long Island Breast Cancer Study Project is currently being conducted by the National Cancer Institute to examine the relationship between environmental exposure and breast cancer in women diagnosed with this disease.<sup>35</sup>

*The recent soil sampling confirms that long-term exposure of residents to soil at the site does present some cancer risk.* The higher levels of pesticides, primarily chlordane and dieldrin, found throughout the yard suggest that an exposure of 30-years would result in a *low* increase in cancer risk. However, cancer risk for former residents is estimated to be much lower than this estimate because no one lived on-site for more than three years. In addition, blood serum analyses found only DDE indicating that these cancer risk estimates may be overly conservative.

<b><u>Cancer Risk</u></b>		
Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a population over a lifetime:		
<u>Term</u>		<u># of Excess Cancers</u>
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000

Cancer risk estimates are not *yes/no* answers but measures of chance (probability) that are often based on extrapolation from high dose animal studies. This extrapolation assumes that there is “no safe dose” of any cancer-causing chemicals. The validity of this assumption is not clear as some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold before initiating cancer. The cancer risk estimates made here for organochlorine pesticide exposure are based on high dose animal studies. No evidence was located suggesting a carcinogenic threshold for these chemicals. Therefore, although considerable uncertainty exists regarding cancer risk estimates made here, such measures are useful in determining the magnitude of a cancer threat.

## Biological Testing

### *Blood Serum*

Five blood serum samples taken from current<sup>c</sup> and former on-site tenants were analyzed for organochlorine pesticides. In addition, two former tenants of the basement apartment also had their blood tested for PCBs. DDE, a metabolite that forms in the body after exposure to DDT, was the only contaminant detected in any of the blood serum analyses. DDE was found in each of the five samples analyzed for pesticides at a maximum of 4.0 ppb which is well below the reference value of 52.9 ppb. The reference value represents the 95 percent upper confidence limit (UCL) of the mean DDE blood serum level found in the general U.S. population during the Second National Health and Nutrition Examination Survey (NHANES II).<sup>36</sup> However, background DDE levels in the U.S. are expected to have declined due to a nation-wide ban on DDT (precursor to DDE) use in July 1972. More recent data compiled by the Centers for Disease Control and Prevention (CDC) predict the 95 UCL of the mean DDE blood serum levels in the U.S. to be 27.5 ppb with a mean of 3.3 ppb.<sup>37</sup> Therefore, the maximum level of DDE detected in the blood of residents who lived at the Able Pest Control site (4.0 ppb) is consistent with what would be expected in the general U.S. population.

No studies were found that correlated blood levels of organochlorine pesticides with adverse health effects. One study found no effect on liver enzyme activity in a population of dairy farmers exposed to heptachlor epoxide, trans-nonachlor and oxychlordane in cows' milk when compared to unexposed dairy farmers. These contaminants are either metabolites or components of chlordane and heptachlor exposure. The blood levels measured in this study exceeded the detections limits used in the present analyses.<sup>38</sup> Since activation of liver enzymes is considered to be a sensitive endpoint for chemicals that exert toxic effects on the liver and other organs, this study indicates that blood levels below the detections limits used here will not result in adverse health effects.

It is possible that detectable levels of other organochlorines may have been present in the blood of residents who left the on-site apartments about 2 years prior to analysis. No data was located with which to estimate the biological half-life of chlordane (and metabolites) or dieldrin in serum. The half-life of PCBs in blood serum has been estimated to range from two to six years indicating that PCBs would have been detected serum.<sup>39</sup>

### *Breast Milk*

Elevated levels of some organochlorine pesticides and PCBs were found in one of two breast milk samples collected from mothers living in each of the two on-site apartments. As shown in Table 2, several contaminants were found in this sample up to seven times above their respective reference values. The reference values used for this comparison represent an estimate of the average levels found in the breast milk of Canadian women with no known exposure.<sup>24</sup> It is important to note that the reference ranges used here are based on 1992 levels that are expected to have declined since that time. In fact, a recent analysis of Canadian breast milk data collected

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<sup>c</sup> These tenants lived on-site at the time of the blood sampling but have since moved out.

from 1967 to 1992 predict that 1999 levels of DDT, and its metabolites DDD and DDE, would be approximately one-half of the 1992 value.<sup>26</sup> Similar declines are predicted for other organochlorines in breast milk.

Estimated doses for an infant exposed to contaminants in breast milk were compared with respective RfDs. Doses estimated for oxychlordane and *trans*-nonachlor exceeded the chlordane RfD.<sup>d</sup> No other contaminants found in breast milk exceeded their respective RfDs. The relatively short exposure duration of infants to contaminants in breast milk (i.e. < 2 years) results in only a *slight* increase in cancer risk from this pathway. This risk does not consider the contribution of other organochlorines such as dioxins/furans which are known to be widespread in human breast milk.<sup>25</sup> Assumptions and calculations used to derive these doses are presented in Appendix C.

*While there is no clear evidence associating adverse health effects in infants exposed to organochlorine pesticides in breast milk, the benefits of breast feeding are well-understood.* Therefore, DOH made no recommendation with respect to continuation of breast feeding for this resident. However, it was recommended that the mother consult with her pediatrician and other physicians who specialize in environmental health. Consequently, an evaluation was conducted by the University of Washington, Pediatric Environmental Health Speciality Unit to which DOH provided the breast milk analytical results. This evaluation concluded that the mother should continue routine infant care and breast feeding.

The contribution of on-site exposure to the levels of organochlorines found in this breast milk sample is not clear. The pesticides of concern here are persistent and expected to exist at low levels in people with no known exposure (i.e. background levels). Older women and women with only one child are expected to have higher background levels of organochlorines in breast milk.<sup>40</sup> The breast milk sample that contained elevated pesticides was taken from a mother who was 34 years of age at the time of the sample and had no previous children. In addition, this resident lived in the upstairs apartment which had lower levels of dust contamination than were found in the basement apartment.

### **Indoor dust**

Exposure to chlordane and dieldrin in indoor dust is expected to contribute to the overall dose received by residents living at the Able Pest Control site. Although indoor dust exposure is difficult to quantify, it can be assumed that accidental ingestion and skin contact with indoor dust is equivalent to that of soil. Using these assumptions, doses estimated from exposure to chlordane and dieldrin in indoor dust did not exceed respective RfDs. However, a *very low* cancer risk is associated with this exposure. Assumptions and calculations used to derive these doses are presented in Appendix C.

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<sup>d</sup> No RfDs are available for oxychlordane and *trans*-nonachlor. The chlordane RfD is considered an appropriate surrogate since oxychlordane is a metabolite of *cis* and *trans*-chlordane and *trans*-nonachlor is a component of chlordane pesticide preparations (i.e., technical chlordane).

The assumption that all the dust is available for direct contact in the same manner as outdoor soil may be conservative. However, contact with dust in high use areas of the home is expected to be longer than that of outdoor soil. In addition, inhalation of dust is not quantified and could contribute to overall exposure. A recent analysis of several lead (Pb) exposure studies found that elevated lead in house dust is associated with increased blood lead levels.<sup>41</sup> This study indicates that the presence of contaminants in indoor dust can result in measurable exposure. Past sampling of soil beneath the foundation along with the extensive soil excavation proposed for the site could allow more contaminated soil to accumulate as indoor dust.

While removal of the contaminated soil from the site will effectively eliminate the source of indoor dust contaminants, existing dust contamination could persist for several years depending upon cleaning habits of new tenants. Studies indicate that contaminants in indoor dust are more persistent than in outdoor soil because of decreased degradation rates.<sup>42</sup> Therefore, exposure to indoor dust could continue several years after outdoor soil removal has been completed.

### **Indoor Air**

No indoor air sampling has been conducted at the site. Chlordane has been shown to persist in indoor air more than one year following termite treatment.<sup>43,44</sup> The persistence of organochlorine pesticides in indoor air could be attributable to the relatively low volatility and slow dissipation from treated surfaces.

The absence of organochlorines in the blood serum of former on-site tenants suggests indoor air levels are not high. However, pesticide residues found in breast milk could, in part, be attributable to inhalation exposure.

### **Preschool Property**

A previous health consultation found that the limited pesticide contamination at a preschool bordering the site posed “no apparent public health hazard” to students or teachers at the school.<sup>1</sup> The contaminated area at the preschool was excavated, re-graded with clean soil and seeded with grass (see Figure 1). However, more recent surface soil sampling in November 1999, found that low levels of chlordane, dieldrin and DDT had apparently migrated back onto preschool grounds at maximum levels of 207, 310 and 64 ppb, respectively.<sup>45</sup> These levels are similar to those found before and are not considered to pose any health hazard to students or teachers. However, Ecology has removed soil in this contaminated area because the maximum level of dieldrin detected does exceed its residential soil cleanup level. Sampling of this area following soil removal confirmed that pesticides were below detection.<sup>46</sup> Ecology will continue to sample off-site soil to ensure that any future migration of contaminants onto preschool grounds will be detected.

## **Community Health Concerns**

Addressed below are specific health concerns received by DOH from on-site residents regarding exposure to organochlorine pesticides.

### **1. One former on-site tenant expressed concerns that her family's pesticide exposure is related to thyroid disease and neurological symptoms including persistent tremors in the arms and hands.**

The association between organochlorine pesticides and these types of health effects as well as other non-cancer health endpoints are discussed above on page 5.

### **2. An additional concern was raised regarding the adequacy of blood serum versus fat tissue analysis in the estimation of organochlorine body burdens.**

Blood serum analysis has been widely used to determine the extent of exposure to various organochlorines. A recent study showed that organochlorines measured in fat correlate well with blood serum at a ratio of approximately 100 to 150.<sup>47</sup> Since organochlorines concentrate in fat tissue, this ratio is explained by the fat content of blood serum which generally ranges from 0.5 to 1.0 percent. These results indicate that blood serum analysis can provide accurate measures of body burden. However, the relatively low levels of fat in serum may result in failure to detect levels that would otherwise be found in a fat or breast milk analysis. Improved analytical methods for serum analyses that provide lower limits of detection can compensate for this discrepancy.<sup>39,48</sup>

The goal of the blood serum analyses was to obtain actual measures of exposure to better estimate the potential for adverse health effects. However, very little data exists relating levels of organochlorine pesticides in blood to health effects. In the absence of such data it is useful to compare blood serum levels with reference values that represent "background" levels expected in populations with no known exposure. Such comparisons can indicate whether site related exposure has caused blood levels to exceed background. As noted above, only DDE was found in blood serum analyses and the level detected was well below its reference value. The detection limits for the serum analyses are considered to be at or below background levels.

### **3. Concerns regarding childhood exposure were expressed to DOH from on-site residents as well as parents and teachers at the Lake Forest Park Preschool students.**

These concerns were addressed in a previous health consultation and are also discussed above on page 10.<sup>1</sup> In addition, two women who gave birth while residing on-site expressed concerns regarding breast feeding. These concerns are addressed on page 8.

## **Environmental Exposure and Children**

The potential for exposure and subsequent adverse health effects are often increased for young children as opposed to older children or adults. For example, children are far more likely to engage in activities that involve “getting dirty.” Playing in dirt, combined with frequent hand-to-mouth activity, provides toddlers with an increased chance of exposure to soil contaminants by way of ingestion and skin contact. In addition to the potential for higher exposures of young children, the risk of adverse health effects is also increased. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity.

DOH made appropriate assumptions to account for the increased exposure of children versus adults relative to the organochlorine pesticides detected in soil and indoor dust. In addition, breast feeding infants were identified as a sensitive sub-population at this site. Evidence of organochlorine pesticides in breast milk heightened this concern and resulted in a referral of one mother to the University of Washington, Pediatric Environmental Health Speciality Unit. Infant exposure to organochlorines in breast milk is discussed on page 8.



## **Conclusions**

- 1) No public health hazard currently exists at the former Able Pest Control property. No residents are currently living in on-site apartments and contaminated soil will be removed prior to reoccupation of these apartments.
- 2) No public health hazard exists for students or teachers at the Lake Forest Park Preschool. Levels of pesticides found in soil at the preschool have not exceeded levels of health concern and contaminated soil has been removed. Monitoring of soil at the Able Pest Control site will ensure that any migration of contaminants onto preschool property will be detected.
- 3) Past exposure to organochlorine pesticides in soil and dust are thought to have posed a public health hazard to former on-site residents. However, analysis of blood serum samples collected from exposed residents detected only DDE at levels below those expected in the general population. Limited data indicates that exposure of former on-site residents was not high enough to result in adverse health effects. More data correlating blood levels with health effects would be useful to better interpret low level exposure to organochlorine pesticides.
- 4) Several pesticides and their metabolites were found at elevated levels in one of two breast milk samples taken from on-site residents. While exposure of infants to these levels of pesticides in breast milk is considered to be higher than average, adverse health effects are not expected. A medical evaluation of the mother and child concluded that normal breast feeding should continue.
- 5) Organochlorine pesticides detected in indoor dust may present an exposure pathway for future residents. Levels of pesticides in carpet dust samples were several times higher in the on-site basement apartment than those found in the upstairs apartment. In addition, soil sampling, excavation and removal may add to indoor pesticide levels through migration of contaminated soil into the house.
- 6) No indoor air testing is available for this site. However, treatment of homes with chlordane for termites results in measured levels of chlordane and heptachlor in indoor air that can persist for more than one year.

## **Recommendations/Public Health Action Plan**

1) Apartments at the Able Pest Control site should remain unoccupied until the scheduled soil excavation and removal is complete. In addition, carpeting should be replaced throughout the upstairs and basement apartments to reduce/eliminate exposure to organochlorine pesticides in indoor dust.

### *Action Proposed:*

- ▶ Ecology has requested that existing carpeting be removed prior to reoccupation of the on-site apartments.

2) Indoor air in the basement apartment should be sampled following remediation to ensure that inhalation exposure is not of concern.

### *Action Proposed:*

- ▶ Ecology has requested that indoor air samples be taken prior to reoccupation of the on-site apartments. DOH will evaluate indoor air sampling conducted at the site.

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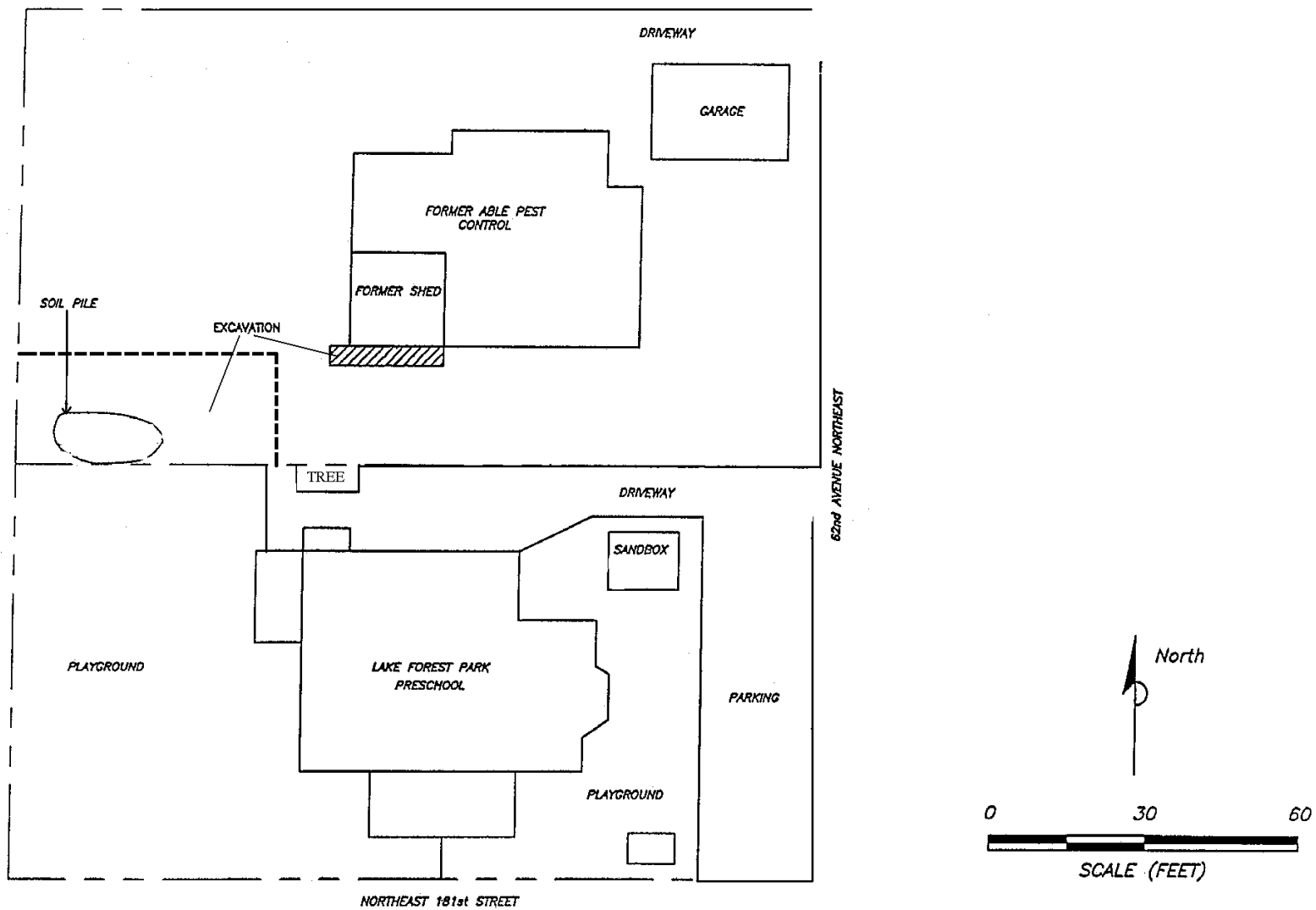
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## **Appendix A:** Figures





**Figure 1:** Former Able Pest Control Property and adjacent Lake Forest Park Preschool (Adapted from Ref. 9).

## Appendix B

**Table B1.** Indoor Dust Sampling Results in parts per million (ppm) for the Able Pest Control Site in Seattle, Washington.

Chemical	On-site		Off-site	
	Basement	Upstairs	Old Carpet <sup>a</sup>	New Residence
Aldrin	< 0.24	< 0.42	< 0.69	< 0.013
alpha-BHC	< 0.24	< 0.42	< 0.02	< 0.013
beta-BHC	< 0.24	< 0.42	< 0.02	< 0.013
gamma-BHC (lindane)	< 0.24	<b>0.45</b>	<b>4.6</b>	< 0.013
cis-Chlordane (alpha)	<b>3.4</b>	<b>0.76</b>	<b>12.0</b>	<b>0.008</b>
trans-Chlordane (gamma)	<b>3.7</b>	<b>0.93</b>	<b>15.4</b>	<b>0.012</b>
4,4' - DDD	< 0.24	< 0.42	<b>0.5</b>	< 0.013
4,4" - DDE	< 0.24	< 0.42	< 0.5	< 0.013
4,4' - DDT	< 0.24	< 0.42	< 0.5	< 0.013
Dieldrin	0.25	< 0.42	<b>0.72</b>	< 0.013
Endrin	< 0.24	< 0.42	< 0.5	< 0.013
Heptachlor	< 0.24	< 0.42	<b>2.0</b>	< 0.013
Heptachlor epoxide	< 0.24	< 0.42	< 1.4	< 0.013
Hexachlorobenzene	< 0.24	< 0.42	< 0.2	<b>0.004</b>
Lindane	< 0.24	< 0.42	<b>4.6</b>	< 0.013
Methoxychlor	< 0.24	< 0.42	<b>4.1</b>	< 0.013
cis-Nonachlor	<b>1.2</b>	<b>0.18</b>	<b>2.1</b>	<b>0.002</b>
trans-Nonachlor	<b>2.9</b>	<b>0.68</b>	<b>9.1</b>	<b>0.005</b>
Oxychlordane	< 0.24	< 0.42	< 0.2	< 0.013
Polychlorinated biphenyls (PCBs)	< 0.24	< 0.42	<b>200</b>	< 0.013

a = Sample from old carpet removed from basement apartment by former tenant.

**Bold** indicates a detection.

## APPENDIX C: Exposure Dose Calculations

The following exposure dose equations were used in conjunction with the exposure assumptions given in the tables below. Assumptions not otherwise noted are derived from the Exposure Factors Handbook published by EPA.<sup>e</sup>

### Ingested Dose - Soil/Dust

$$ID = \frac{C \times IR \times CF \times EF \times ED}{BW \times AT}$$

### Dermal Absorbed Dose - Soil/Dust

$$DAD = \frac{DA_{\text{event}} \times EF \times ED \times SA}{BW \times AT}$$

$$DA_{\text{event}} = C \times AF \times ABS \times ADJ \times CF$$

### Ingested Dose - Breast Milk

$$ID = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

ID =	Ingested Dose - (mg/kg-day)
C =	Concentration - (ppm or mg/kg)
IR =	Ingestion Rate - (mg/day)
CF <sub>soil</sub> =	Conversion Factor for soil - (0.000001 kg/mg)
DAD =	Dermal absorbed dose - (mg/kg-day)
DA <sub>event</sub> =	Absorbed Dose per Event - (mg/cm <sup>2</sup> -event)
SA =	Exposed Surface Area of Skin - (cm <sup>2</sup> )
AF =	Soil/Skin Adherence Factor - (mg/cm <sup>2</sup> )
ABS =	Absorption Fraction - (unitless)
ADJ =	Absorption Adjustment Factor - (1.0)
EF =	Exposure Frequency - (days/year)
ED =	Exposure Duration - (years)
BW =	Body Weight - (kg)
AT =	Averaging Time - (days)

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<sup>e</sup> United States Environmental Protection Agency. Exposure Factors Handbook: Volumes I, II and III. August 1997. EPA/600/P-95/002Fa.

### Non-Cancer Dose Calculations

Exposed Population	Media	Contaminant	Concentration <sup>a</sup> (ppm)	Exposure Route	Ingestion Rate (mg/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Estimated Dose (mg/kg-day)	RfD (mg/kg-day)	Hazard Quotient
Young Child	Soil	aldrin	0.35	Ingestion/ Dermal Contact <sup>b</sup>	200	350	5	15	1825	5.8E-06	3.0E-05	0.2
		chlordane	74.9							1.1E-03	5.0E-04	2.1
		DDD	0.9							1.5E-05	5.0E-04 <sup>c</sup>	0.03
		DDT	1.8							3.0E-05	5.0E-04	0.06
		dieldrin	8.8							1.4E-04	5.0E-05	2.9
		heptachlor	11.4							1.9E-04	5.0E-04	0.4
		heptachlor epoxide	0.28							4.7E-06	1.3E-05	0.4
										Hazard Index		6
Infant	Breast Milk	pp-DDE	18.8 ppb	Ingestion	0.69	365	2	7.9	365	1.6E-03	5.0E-04 <sup>c</sup>	3.3
		op-DDT	0.15 ppb							1.3E-05	5.0E-04	0.03
		pp-DDT	0.12 ppb							1.0E-05	5.0E-04	0.02
		dieldrin	0.16 ppb							1.4E-05	5.0E-05	0.3
		heptachlor epoxide	0.23 ppb							2.0E-05	1.3E-05	1.5
		lindane	0.08 ppb							7.3E-06	3.0E-04	0.02
		<i>trans</i> -nonachlor	0.62 ppb							6.6E-05	5.0 E-04 <sup>d</sup>	0.1
		oxychlordane	0.75 ppb							5.4E-05	5.0 E-04 <sup>d</sup>	0.1
										Hazard Index		5
Young Child	Indoor Dust	chlordane	7.1	Ingestion/ Dermal Contact <sup>b</sup>	200	350	5	15	1825	1.0E-04	5.0E-04	0.2
		dieldrin	0.25							4.1E-06	5.0E-05	0.08
										Hazard Index		0.3

a = Soil concentrations represent the 95% Upper Confidence Limit (UCL) of soil samples taken from accessible areas of the Able Pest Control site.

b = Dermal Contact Assumptions - SA = 2,900, AF = 0.2 mg/cm<sup>2</sup>, ABS<sub>chlordane</sub> = 0.04, all other pesticides are assumed given a default ABS<sub>default</sub> = 0.1.

c = This is the DDT RfD used as a surrogate for DDE.

d = This is the chlordane RfD used as a surrogate for *trans*-nonoachlor and oxychlordane.

Hazard Quotient = Estimated Dose/RfD

Hazard Index = Sum of hazard quotients.

## Cancer Dose Calculations

Exposed Population	Media	Contaminant	Conc. <sup>a</sup> (ppm)	Exposure Route	Ingestion Rate (mg/day)	Surface Area (cm <sup>2</sup> )	Adherence Factor (mg/cm <sup>2</sup> )	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Estimated Dose (mg/kg-day)	Cancer Potency Factor	Cancer Risk		
Young Child  Older Child  Adult	Soil	Aldrin	0.35	Ingestion/ Dermal Contact <sup>b</sup>	200	2900	0.2	350	5	15	27375	6.9E-07	17	1.2E-05		
		Chlordane	74.9									1.2E-04	0.35	4.3E-05		
		DDD	0.9									1.8E-06	0.24	4.2E-07		
		DDT	1.8		100	2900	0.2		10	41		3.6E-06	0.34	1.2E-06		
		Dieldrin	8.8									1.7E-05	16	2.8E-04		
		Heptachlor	11.4			5700	0.07		15	72		2.2E-05	4.5	1.0E-04		
		Hepatachlor Epoxide	0.28		5.6E-07							9.1	5.1E-06			
												Sum of Soil Cancer Risk		4E-04		
Infant	Breast Milk	pp-DDE	18.8 ppb	Ingestion	0.69	NA	NA	365	2	7.9	27375	4.4E-06	0.34	1.5E-06		
		op-DDT	0.15 ppb									3.4E-08	0.34	1.2E-08		
		pp-DDT	0.12 ppb									2.8E-08	0.34	9.5E-09		
		dieldrin	0.16 ppb									3.7E-08	16	5.9E-07		
		heptachlor epoxide	0.23 ppb									5.3E-08	9.1	4.8E-07		
		<i>trans</i> -nonachlor	0.62 ppb									1.4E-07	0.35 <sup>c</sup>	5.1E-08		
		oxychlordane	0.75 ppb									1.8E-07	0.35 <sup>c</sup>	6.1E-08		
												Sum of Breast Milk Cancer Risk		3E-06		
Young Child  Older Child  Adult	Indoor Dust	Chlordane	7.1	Ingestion/ Dermal Contact <sup>b</sup>	200	2900	0.2	350	5	15	27375	1.2E-05	3.5E-01	4.1E-06		
Dieldrin		0.25	100		2900	0.2	10		41	4.9E-07		1.6E+01	7.9E-06			
			100		5700	0.07	15		72							
												Sum of Indoor Dust Cancer Risk		1E-05		

a = Soil concentrations represent the 95% Upper Confidence Limit (UCL) of soil samples taken from accessible areas of the Able Pest Control site.

b = Dermal absorption values (ABS) are as follows: ABS<sub>chlordane</sub> = 0.04, all other pesticides are given a default ABS<sub>default</sub> = 0.1.

c = This is the chlordane cancer potency factor used as a surrogate for *trans*-nonoachlor and oxychlordane.

## **CERTIFICATION**

This Able Pest Control Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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